CYCLOCEPHALA (OCHROSIDIA) BOREALIS IN CONNECTICUT 1

By J. Peter Johnson

Assistant entomologist, Connecticut Agricultural Experiment Station

INTRODUCTION

Since grubs of annual species of scarabaeidae have become more prevalent and injurious to turf in the northeastern part of the United States during the last two decades, it is increasingly important that the biology and description of such pests be made available to economic entomologists.

Cyclocephala borealis Arrow 2 has recently become a serious pest of lawns in Connecticut. In order to determine how to combat it successfully, the studies described below have been carried on over

the past 3 years.

Cyclocephala borealis occurs as far south as Alabama and westward to California,3 its range extending over most of the United States. It was found in Connecticut for the first time when grubs collected from injured turf on an estate in Westport (4),4 November 12, 1931,

were identified as larvae of this scarabaeid.

During October 1936, two different lots of grubs were received for identification from Greenwich, where severe lawn damage had occurred. In the fall of 1937, grubs were received from East Norwalk, Fairfield, and Greenwich. Upon investigation it was found that approximately 15 acres of lawn area had been badly injured or destroyed by the insect. In 1938, additional infestations were found in Greenwich and Norwalk, and another was reported from East Hartford. Other infestations were found in 1939 on two golf courses in Fairfield and on one course in Stamford. It is evident from the information at hand that a scattered infestation exists in the shore towns in southwestern Connecticut.

This insect is usually a pest of grassland, and a brief account of its injuriousness to lawns in Ohio, together with certain experiments in control methods, has been given by Neiswander (8). It has also been reported by Swenk (11) as injurious to winter wheat in Nebraska.

Certain morphological and biological studies of Cyclocephala (Ochrosidia) borealis have been made in recent years. Saylor (9) has described the adult male and published illustrations of the male genitalia. (10) has described the larva and illustrated the epipharynx and raster. Neiswander (8) also reported on the life history of this insect. biology of C. (villosa) borealis as reported by Hayes (6) in 1918 was really that of C. immaculata Oliv. (7, p. 67).

¹ Received for publication June 15, 1940.
2 Dr. E. A. Chapin, U. S. National Museum, confirmed the identification of this scarabaeid as *C. borealis*Arrow from duplicate material submitted to him.
3 U. S. Department of Agriculture, Bureau of Entomology and Plant Quarantine. The INSECT PEST SURVEY BULLETIN. 1930, 1931, 1934, 1937, 1938. [Mimeographed.]
4 Italic numbers in parentheses refer to Literature Cited, p. 86.

SYSTEMATIC POSITION

This scarabaeid was originally described by Burmeister, under the subfamily Dynastinae, tribe Cyclocephalini, as Cyclocephala villosa. Since two species received the name of Cyclocephala villosa, the first being Blanchard's Bolivian species and having priority, Arrow (1, p. 172) renamed the North American species borealis. Casey (5, pp. 109-147), in his review of the subfamily Dynastinae, placed villosa in the genus Ochrosidia. Arrow considers Ochrosidia as a subgenus. The Leng Catalogue (2, p. 54) lists the species as Cyclocephala borealis Arrow.

DESCRIPTION AND LIFE HISTORY

THE EGG

The eggs of Cyclocephala borealis when laid are pearly white, ovoid, and delicately reticulate. The sides of some are nearly parallel, with rounded ends. When first laid, 15 eggs had a mean length of 1.68 ± 0.02 mm. and a mean breadth of 1.3 ± 0.01 mm. The eggs begin to swell when 2 or 3 days old, reaching a maximum size just before hatching. Eight other eggs measured 1 day before hatching had a mean length of 1.68 ± 0.03 mm. and a mean breadth of 1.58 ± 0.04 mm. It will be noted that the mean length of the newly laid eggs is the same as that of those ready to hatch, 1.68 mm. This would indicate that the egg enlarges transversely during the development of the embryo.

While eggs have been collected in the field as early as June 29, deposition continues throughout the flight period. The majority are laid in turf between 4½ and 6 inches below the surface. Some have been found at a depth of only 1½ inches but none below a depth of 6 inches. The maximum number of eggs laid by a single female beetle under insectary conditions was 29 and the minimum 3. A total of 362 eggs was laid by 32 females, the average being between 11 and 12 per female. Females, collected in the field from pupal skins on July 6 and placed with males on July 7, deposited eggs on July 8. The majority of the eggs in the insectary hatched in 20 to 22 days. Just before the larva hatches, the mandibles and portions of the head capsule, which have become darkened in color, are visible through the chorion.

THE LARVA

The larva passes through three instars before attaining full growth. The mean dorsal length of twenty-one 1-day-old larvae was 5.08 ± 0.05 mm. The mean cranial width of 20 first-instar larvae was 1.57 ± 0.01 mm. The mean cranial width of 15 second-instar larvae was 2.32 ± 0.01 mm. Full grown third-instar larvae differ somewhat in size. The mean length of 27 specimens was 22.7 ± 0.12 mm., individuals ranging from 20 to 24 mm. The mean cranial width of 44 specimens was 4.12 ± 0.01 mm.

The head of the full-grown larva is yellowish brown in color, and the body is white. The anal slit is transverse and arcuate. The raster has a sparse group of coarse, long, hooked, brownish spines, which become larger toward the anal slit. Figures of the full-grown larva, together with structural characteristics of the epipharynx, mandibles, maxillae, and prothoracic and metathoracic legs are given

in figure 1.5

 $^{^{5}}$ The figures of the pupae and the epipharynx of C, immaculata were prepared by the author; all others are by Elizabeth Kaston.

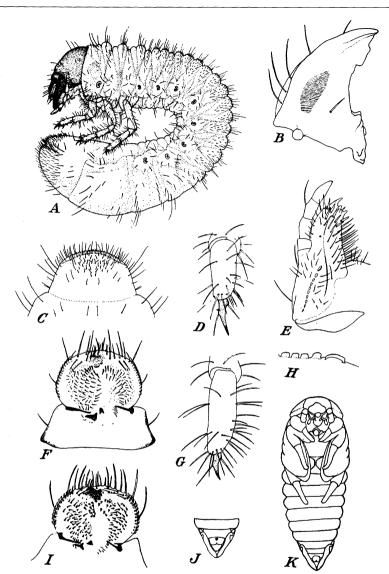


FIGURE 1.—Larva and pupa of Cyclocephala borealis: A, Larva entire; B, right mandible of the larva, showing area of striation; C, ventral aspect of the anal segment of the larva; D, prothoracic leg of the larva; E, cephalic aspect of the left maxilla of the larva, showing one very large, seven median, and two small stridulating teeth; F, epipharynx of the larva; G, metathoracic leg of the larva; H, the five anterior stridulating teeth of the left maxilla of the larva; I, epipharynx of C. immaculata; J, ventral view of the last three segments of the female pupa; K, ventral view of the male pupa.

Morphologically the larvae of *Cyclocephala borealis* Arrow and *C. immaculata* Oliv.⁶ are very similar, but the haptomeri of the two

⁶ Appreciation is hereby acknowledged to Dr. P. O. Ritcher for the receipt of many fine larval specimens of *C. immaculata* from Kentucky.

species are somewhat different in structure. A figure of the epipharynx of *immaculata* is shown in figure 1, K. The haptomerum of *borealis* has a definite single, large, sclerotized, rounded plate and straight apex, with a deep notch to the left of the center of the zygum. The darkened chitinized anterior edge on the right lobe is about four times as broad as it is deep. The breadth of the left lobe likewise is about twice its depth. In *immaculata* the rounded, sclerotized plate does not terminate as definitely as that of *borealis*, and the notch is more centrally located but rather indistinct. The lobes are more nearly equal in size, with the dark, chitinized apical edge of the right lobe more than two times as broad as it is deep, while the breadth and depth of the left lobe are about equal. The dark, chitinized apices of the lobes are more distinct than in *borealis*.

Feeding begins almost immediately after hatching, and larvae less than 1 day old are discolored by food in the alimentary tract. The larvae feed on organic matter and on the roots of plants, in Connecticut

primarily on the roots of turf.

Damage to turf usually occurs in September or October and in the spring. Three diggings in different localities where such injury was evident yielded, respectively, 33, 48, and 64 third-instar larvae to 1 square foot. Third-instar larvae were observed in the field on September 7, and it is evident from field observations that the larvae are in this instar when they go into hibernation.

The larvae react to changes in soil temperature in a manner similar to that of other scarabaeid larvae, descending at the onset of cold weather in the fall and ascending in the spring. Larvae in individual cases will descend to a depth of 18 inches to hibernate. In 1939 the descent began early in November, when the larvae were found distributed at depths ranging from 2 to 14 inches, as shown in table 1. One digging made on April 12, 1938, before the upward movement of the grubs took place, revealed 11 larvae in the upper 3 inches of soil, 19 larvae at a depth of from 3 to 9 inches, and 1 larva more than 9 inches deep. Winter mortality may be heavy; in one digging 30 of 61 grubs found were dead. At a later date in diggings made elsewhere, many dead grubs were noted at hibernation depths.

Table 1.—Depth to which larvae of Cyclocephala borealis descend to hibernate, 1939

Date	Number of larvae found at depth indicated (inches)												
	2	3	4	5	6	7	8	9	10	11	12	13	14
Nov. 9 Nov. 14	6.	5 2	0 4	4 4	3	4 2	4 6	2 3	2 5	2 0	1 2	0	0

THE PUPA

The pupa when newly transformed is creamy white in color, but it gradually turns a reddish brown. The mean dorsal length of 16 preserved pupae was 16.78 ± 0.18 mm. Figure 2 illustrates the differences between the sexes. The male genital segment (ninth abdominal) bears a pair of conspicuous lobes. In the female this segment is partially divided by a short median suture, anterior to which is situated the gonotreme. The sex of the older pupae may also be determined by observing the sexual differences of the tibial spurs through the cuticle of the prothoracic legs.

The pupal period occurs during June. On June 8, 1939, a digging adjacent to the shore of Long Island Sound yielded 25 larvae, 51 prepupae, and 41 pupae. A second digging was made at the same place on June 19, 1939, and 3 larvae, 2 prepupae, and 36 pupae were

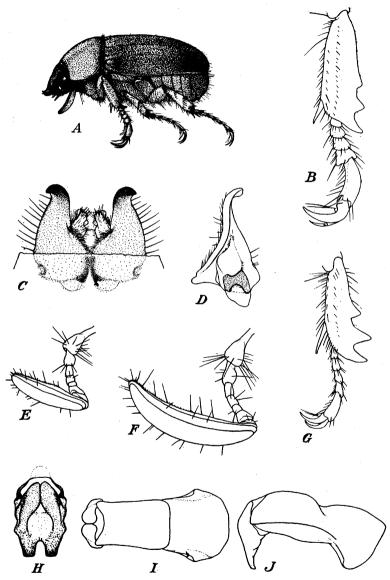


FIGURE 2.—Cyclocephala borealis: A, Adult male; B, prothoracic leg of the adult male; C, dorsal aspect of the mandibles of the adult male in situ; D, mesal aspect of the right mandible of the adult; E, female antenna; F, male antenna on same scale as E; G, prothoracic leg of the adult female on same scale as B; H, end view of the male genitalia; I, dorsal view of the male genitalia; J, lateral view of the male genitalia.

found. An examination of larvae placed in a 24-inch glazed tile the preceding fall was made on June 9, 1939, and 42 larvae and 2 prepupae were found. About 75 larvae were used for rearing purposes at room temperature and also at 78° F. The prepupal period was 4 to 5 days in length. The length of the pupal period varied from 11 to 16 days, but the largest number emerged as adults on the fourteenth and fifteenth days.

THE ADULT

The adult is chestnut brown in color and covered with fine hairs, the male being slightly larger and somewhat darker than the female. The mean dorsal length of 22 adult males collected from pupal skins was 11.84 ± 0.10 mm, and the breadth 6.76 ± 0.06 mm. The mean dorsal length of 22 females collected from pupal skins was 11.03 ± 0.07 mm., and the breadth 6.66 ± 0.04 mm. The males are distinguished by their larger tarsal claws, shorter and narrower tibial spurs, and longer antennal lamellae. In figure 2 are drawings of a male, the prothoracic legs and antennae of the male and female, and the male genitalia. The body of Cyclocephala borealis, (3, pp. 989-990), is pubescent above, and the antennal club of the male is longer than all the other antennal joints together. C. immaculata is smooth above, and the antennal club of the male is shorter than all the other antennal joints together.

The adults are nocturnal in habit and remain in the soil during the day. Careful observation during the evening when the adults were active and again during daylight hours failed to indicate feeding of any kind. The alimentary tract was empty and atrophied in all specimens examined. The mandibles are fully developed but apparently unfitted for chewing, for they are anteriorly excurvate rather than

incurvate (fig. 1, C).

Just about dusk, or half an hour before dark, on warm, humid evenings, adults may be observed emerging from the soil and climbing to the tips of the grass in lawns. Occasionally one will take wing and fly rapidly just above the ground. As the darkness deepens, more and more beetles emerge and greater activity is observed. From investigations made during the last 2 years when adults were present, it appears that males are predominant in activity and flight. They usually fly from 1 to 2 feet above the ground in search of females. Some, however, will fly somewhat higher and dart away in the dark or toward a light to which they are attracted. When the insect takes to flight, the wing vibrations have a characteristic sound. Flight and general activity cease before midnight. On cool evenings, flight is lessened and the adults are present only for a brief period.

The female beetles emerge and rest on the surface of the soil, if it is

void of grass, or in the turf areas ascend to the tips of the grass. In a moment they are captured by a male, and copulation takes place directly. The males clasp the females along the edge of the elytra behind the legs with their tarsal claws. The females often move about, carrying the males. If disturbed, when single or paired, the adults invariably immediately seek shelter in the grass or loose soil.

In the rearing experiments, adults were removed directly from the soil in their pupal cases, they mated the next day, and eggs were obtained the third day. When individuals were placed together upon collection from their pupal cases in the field, mating immediately took place, and the following day eggs were obtained.

In 1938 the first adults were captured around the lights and windows of a private garage on the evening of June 24. The largest number

were captured about July 5, and the last on July 25.

The life cycle requires 1 year; and the stages, briefly summarized, are as follows: Egg, 20 to 22 days in June and July; larva, 10 to 11 months from July to June; prepupa, 4 to 5 days in June; pupa, 11 to 16 days; and adult, 5 to 25 days in June and July. As the transformations do not all occur at the same time, there is overlapping of the stages.

CONTROL

The larvae are to some extent parasitized by a species of Tiphia as yet undetermined. Of 1,000 larvae examined, 25 were found to

be so parasitized.

Applications of lead arsenate, made in 1938 under the author's direction in Westport and Greenwich at the rate of 20 and 30 pounds, respectively, to 1,000 square feet of lawn, gave excellent control. Neiswander (8) reports that he obtained approximately 70 percent control in 1 month, using lead arsenate at the rate of 10 pounds to 1,000 square feet. He also reported good control by applications of

carbon bisulfide emulsion diluted with water.

Light traps were used by the author in Westport to capture adult beetles. At first the traps were suspended on standards 3 to 4 feet above the ground, but after the flight habits of the beetles were observed, the traps were set directly on the ground and an increased number were captured. Homemade traps, consisting of an ice-box drip pan containing water with a layer of kerosene oil one-fourth of an inch in depth, four pieces of window glass 9 by 12 inches placed vertically to serve as baffles, and a 100- or 150-watt frosted bulb suspended directly above the baffles, were very successful. A 300watt daylight bulb was tried in the area of immediate infestation but was not so successful as the lower-powered bulbs.

Three such traps were used in one area of about 3 acres and a total of 18.967 beetles were captured. Of 9.029 adults captured in two of the traps and determined for sex, 8,996, or 99.63 percent, were males and 33, or 0.37 percent, were females. The traps were in operation from June 25 to July 29. Thirteen of the females were captured on the night of July 5 when the maximum catch was made, and the remaining 20 were taken on 6 other nights. This result was similar to that obtained by Neiswander (8). Light traps are not recommended for control. However, if the beetles should be attracted by lights to residences or recreation centers and become a nuisance, light traps

might be useful.

SUMMARY

Cyclocephala borealis Arrow was first found in Connecticut in 1931, in the town of Westport, where larvae were destroying lawn turf. It has since been found in several other towns in the southwestern part of the State, and during the past 9 years has injured or destroyed many acres of fine turf on lawns and golf courses.

The adults are chestnut brown in color and are present for about 1 month, beginning about June 25. They are nocturnal in habit, emerging from the soil about dusk, and are active during the early

hours of the evening. The males are the more active.

Oviposition begins the first or second day after the adults first emerge, and the eggs hatch in about 3 weeks. The larvae pass through three instars, usually entering the third instar in early September. A field population of 64 larvae per square foot was recorded in one lawn. The larvae feed upon the roots of grass, and turf injury may first appear in September. The larvae ascend and descend in the soil with the rise and fall of the soil temperatures in the spring and fall. Hibernation occurs in the larval stage during the winter at depths varying from 2 to 18 inches, with the majority of the larvae at depths between 3 and 9 inches. The larvae complete their growth by late May or early June. The insect spends from 4 to 5 days as a prepupa in early June. It remains in the pupal stage some 2 weeks, emerging as an adult about the third week in June. The adults have not been observed to feed, and their mouth parts are unsuited for feeding.

Both male and female beetles are attracted to lights. However, light traps capture a great predominance of males and are not recommended for control. The larvae may be controlled by treating the turf with lead arsenate or carbon bisulfide emulsion diluted with

water.

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